REVISITING PATH 26 POWER FLOW ASSUMPTIONS

STAFF PAPER

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Introduction and Summary

This study identifies the problems and limitations associated with making deterministic assumptions about the amount of capacity flowing on Path 26 between Northern California and Southern California during periods of peak summer demand. The paper also provides a more detailed description of California Energy Commission (Energy Commission) staff's concerns regarding the California Public Utilities Commission's (CPUC) final decision (D.07-12-052) in the 2006 Long-term Procurement Proceeding (LTPP, R-06-02-013)). This decision based approval of Pacific Gas & Electric's (PG&E) procurement need determination on an Energy Commission assessment of physical system capabilities that was never intended to be used for financial or contractual purposes. This staff paper will be updated as staff completes additional analysis.

Volatility in the amount of capacity flowing on Path 26 during the summer weekday peak period is characteristic of the last three years. The staff reviewed actual California Independent System Operator (California ISO) flow data for Hour Ending (HE) 1600 which shows as much as 3,608 megawatts (MW) flowing from North to South on June 30, 2006 to as little as 1,175 MW flowing South to North on July 8, 2008, a range of over 4,500 MW. However, when comparing the power flows against the 631 3-Day average temperature[1] for the PG&E service territory, several trends appear. **Figure 1** provides a summary of the PG&E weekday power flow trends for the 2006 to 2008 period.

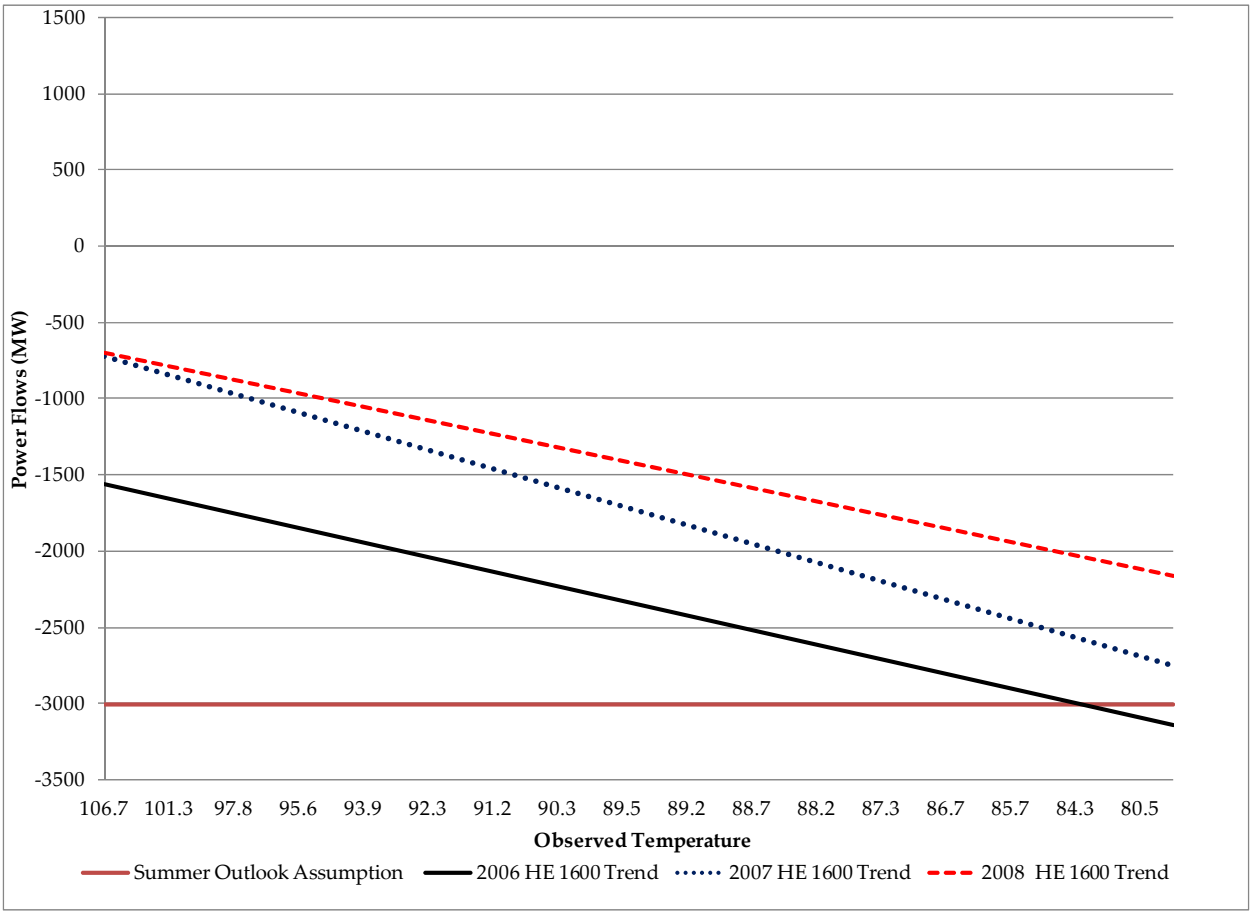
In reviewing the underlying data used to create **Figure 1** and the tables presented in Appendix A, the staff reached the following basic conclusions:

- Higher temperatures in the PG&E service territory generally result in less capacity flowing North to South on Path 26.
- With improved reserve margins and mild temperatures in Southern California, significantly less capacity flowed North to South on a daily basis in 2008 than in 2006 or, to a lesser extent, 2007.
- The 3,000 MW North to South capacity flow assumption used in the Energy Commission Summer Supply and Demand Outlook reports since 2006 and in the CPUC's LTPP decision D.07-12-052 is clearly not correct.
- Identifying the correct single value for capacity flowing on Path 26 to use in a deterministic forecast will be difficult, if not impossible.

[1] The "Max631" formula applies a factor of 60 percent to a given day's high temperature, a 30 percent factor to the previous day's, and a 10 percent factor to the high temperature on the day 2 days prior to the given day.

- Between 100 MW to 1,100 MW North to South appears to be a reasonable range of power flow values when PG&E 3-Day average temperatures exceed 99 degrees.

Figure 1: Path 26 Weekday 2006 – 2008 Summer Power Flow Trends (MW) Sorted by PG&E 3-Day Moving Average Temperature (Negative number indicates North to South)



Source: CA ISO Subpoena data and Energy Commission Staff

Figure 2 thru **Figure 4** illustrates the complete power flow data set used to create the trend lines in **Figure 1**. The actual observed power flows vary a great deal from day to day throughout the summer period during each of the last three years. However, when reviewing the power flow data during periods of high temperatures in Northern California, the amount of variation decreases substantially and provides the consistent trend of less power flowing North to South.

The Energy Commission Staff Report, *Summer 2007 Electricity Supply and Demand Outlook*, identified power flows between Northern and Southern California as a topic requiring additional study and asked for stakeholder input on how to correctly model Path 26. There were no comments or suggestions filed on the topic.

In the 2006 LTPP, PG&E claimed that an Energy Commission study had concluded that 3,000 MW of generation would be exported over Path 26 during the peak hour, and used this value in estimating the reserve margin for their service area. Energy Commission staff testified that PG&E's use of this value was inappropriate since it was based on a physical system capability and not designed to deal with contractual, financial or market based analysis. The staff also testified that the correct number was likely to be lower and called for further analysis. The final decision (D.07-12-052) in that proceeding disregarded Energy Commission staff testimony, without explanation.

The CPUC Resource Adequacy proceeding (R.05-12-013) has determined that Path 26 should be counted analogously to a Resource Adequacy import path and adopted (D.07-06-029) a Joint Proposal of the California ISO, PG&E, San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), and The Utility Reform Network (TURN) to implement a Path 26 Counting Constraint (Joint Proposal) beginning with the 2008 Resource Adequacy compliance period.

Figure 1 shows that the 2006 LTPP final decision over estimated the amount of capacity flowing North to South on Path 26 during PG&E peak demand periods by at least 1,900 MW. The correct Path 26 power flow assumption to be used in future need determinations and planning reserve margin studies needs to be identified to ensure the appropriate amount of capacity is procured in future proceedings. Energy Commission staff recommends that the CPUC take one of the following approaches:

- Develop a CPUC stakeholder working group to further study the issue in an attempt to come to consensus on the most appropriate power flow assumption to use for Path 26 for the purpose of CPUC LTPP and Energy Commission Summer Outlook Report.
- Work with Energy Commission staff, Joint Proposal proponents, and other interested parties to determine effectiveness of the Path 26 Counting Constraint and its significance to this discussion.
- Explore additional alternatives presented by stakeholders or other interested parties.

Path 26 Background and Assumptions

Path 26, as defined by the Western Electricity Coordinating Council (WECC)[2], is comprised of three 500 kV lines that connect PG&E's system at Midway to the SCE system at Vincent. The path has an accepted North to South rating of 4,000 MW and an existing South to North rating of 3,000 MW. Energy Commission staff first divided the CA ISO region into two sub-regions for analytical purposes in the *Summer 2005 Supply and Demand Outlook*. Path 26 was selected as the dividing point since it provided a clean interconnect between PG&E and SCE service territories and because there were significant transmission limitations that impacted the California ISO's ability to move power from Northern California (North of Path 26, or NP 26) to Southern California (South of Path 26, or SP 26), which had much lower reserve margins at that time.

[2] WECC 2008 Path Rating Catalog, January 2008.

By electing to split the California ISO into two sub-regions, the staff considered capacity flowing on Path 26 an import into the SP 26 region and an export from NP 26 during time of peak demand, similar to interchange assumptions from a neighboring state with a surplus. The difference between Path 26 and an interstate path is that the California ISO acts as the single balancing authority for the two regions on either side. For this reason, the California ISO has the ability to send power in either direction to serve that region at the time of demand. Since the SP 26 region had much lower planning reserve margins than NP 26 in 2005, 3,000 MW was assumed to be flowing from North to South. Since NP 26 historically peaks in July to early August and SP 26 peaks between the middle of August and middle of September, there is load diversity between NP 26 and SP 26, and the coincident peak for the two regions is lower than the sum of the two regions individually.

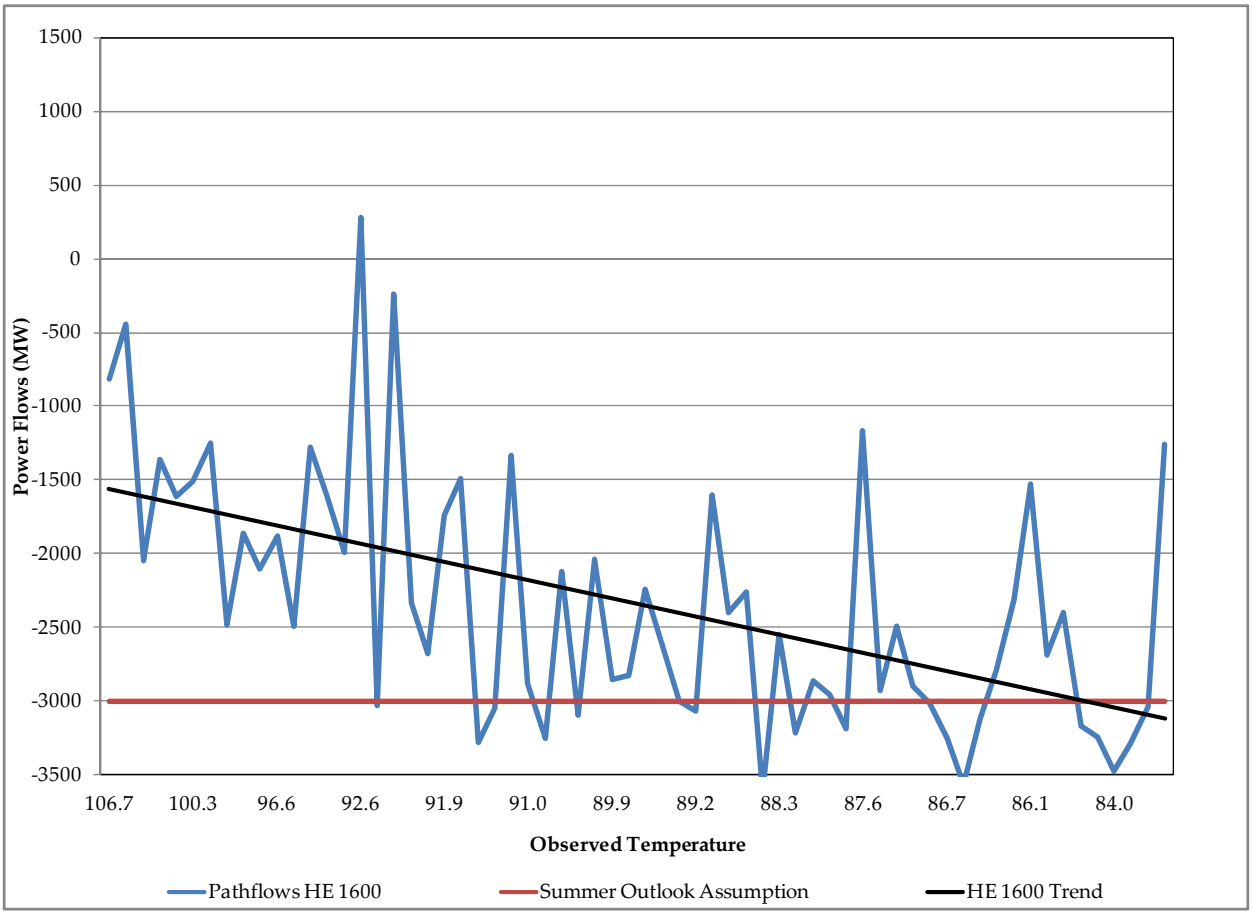
Load diversity, in combination with the California ISO serving as the single balancing authority, provides a more flexible, efficient, and reliable system for both regions. However, it also creates an accounting challenge for the CPUC in the Resource Adequacy and LTPP proceedings and the Energy Commission's Summer Outlook since it is difficult to assign the correct capacity to either region or the Load Serving Entities (LSE) within each region. This is a much greater challenge today than in 2005 as improved planning reserve margins in SP 26 over the last three years make it less reliant on surplus power from NP 26 for all but a few days each summer. During this same period, NP 26 has seen its reserve margin decline, although the region still maintains a surplus capacity. A steady decrease in the amount of capacity being sent from NP 26 to SP 26 occurred in each of the last three years. In fact, there were several days in 2008 that capacity flowed the opposite direction, resulting in more than a 4,000 MW swing from the 3,000 MW North to South assumption (see **Figure 4**).

California electricity peak demand levels are driven by temperature because air conditioning contributes a large portion of the California summer peak demand. However, peak electricity demand does not always occur in the hottest day of the year. There is a strong correlation between peak electricity demand and a buildup of high temperatures over several days. Two regional temperature indices, PG&EMax631 and SCEMax631, used for this analysis are weighted averages of the observed temperatures at various weather stations. The weights are based on air conditioner saturations in these areas and combine the current day (60 percent), and past two days' temperatures (30 percent and 10 percent). The Energy Commission's Demand Analysis Office staff uses the same indices in peak load forecasting and finds them to be highly correlated with peak load. A temperature index is used to ensure that the days that are selected are actually potentially high load days. Selecting the highest load day of a month or year may result in a sample of only somewhat above average temperature days in a below normal year or month.

The staff compared the Path 26 weekday flows against the corresponding Max631 3-Day moving average for the PG&E service area. **Figure 2** thru **Figure 4** provide the results for 2006, 2007 and 2008.

During the 2006 summer period, North to South power flows reached the 3,000 MW level on several occasions. **Figure 2** illustrates that when temperatures exceeded 100 degrees, the observed power flows dropped to a range of between 500 and 2,000 MW North to South.

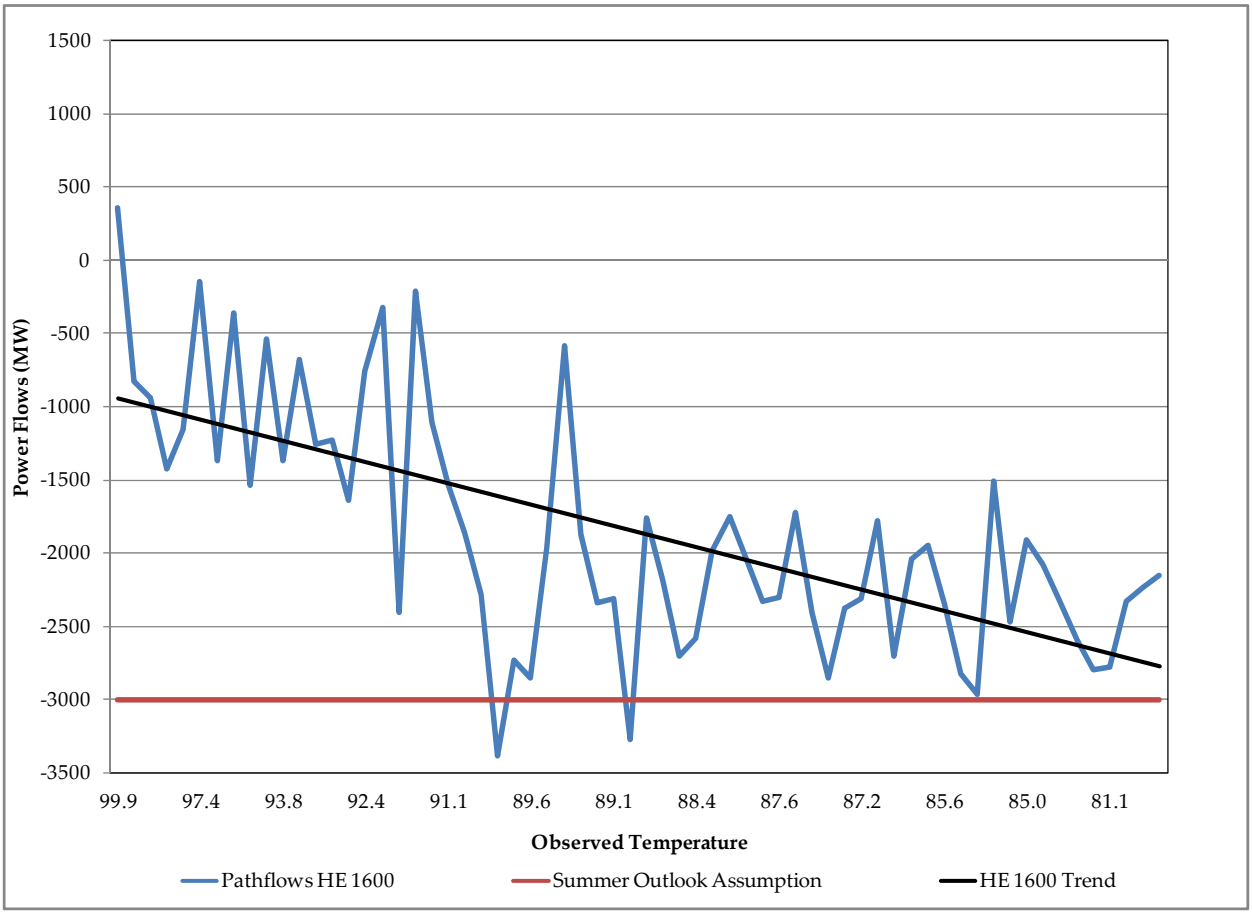
Figure 2: Summer 2006 Path 26 Weekday Flows (MW) Sorted by Temperature (Negative number indicates North to South)



Source: CA ISO Subpoena data and Energy Commission Staff

Summer 2007 observed power flows shown in **Figure 3** indicate a wide disparity from the 3,000 MW North to South assumption currently used in the Summer Outlook and PG&E's need determination. North to South power flows only reached the 3,000 MW level on two occasions and during periods of increased temperatures, consistently dropped to below 1,500 MW.

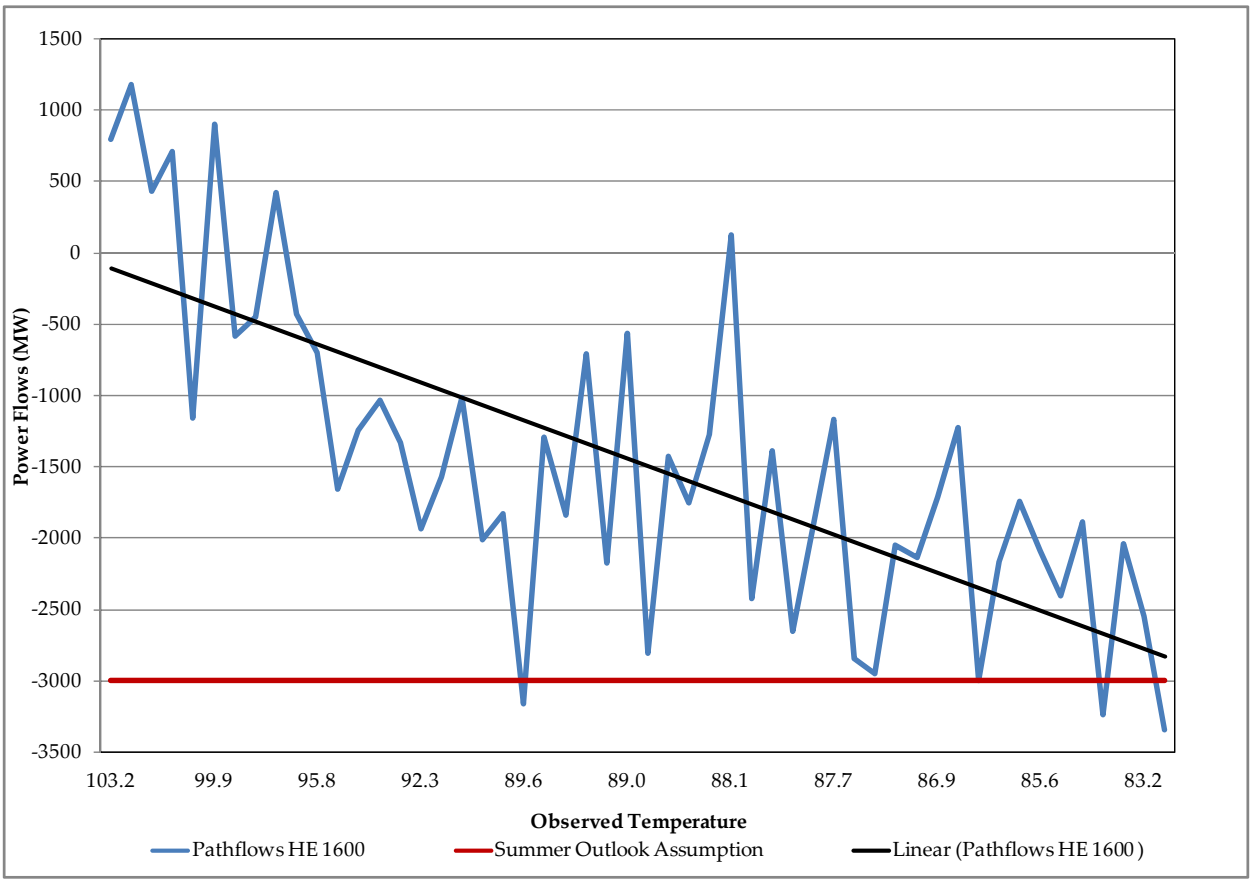
Figure 3: Summer 2007 Path 26 Weekday Flows (MW) Sorted by Temperature (Negative number indicates North to South)



Source: CA ISO Subpoena data and Energy Commission Staff

Figure 4 provides the 2008 power flow observations only thru the end of August due to limited data availability. Similar to 2007, North to South power flows on reached the 3,000 MW level on three occasions. In contrast to the data for 2006 and 2007, power flows reversed on several days and flowed South to North during periods of increased temperatures.

Figure 4: Summer 2008 Path 26 Weekday Flows (MW) Sorted by Temperature (Negative number indicates North to South)



Source: CA ISO Subpoena data and Energy Commission Staff

A study of the 2006 thru 2008 Path 26 power flows presented in **Figure 1** thru **Figure 4** clearly indicates that the 3,000 MW North to South assumption used in Summer Supply and Demand Outlook reports since 2006 and in the CPUC's LTPP decision D.07-12-052 is no longer valid. Energy Commission staff will use an assumption that is significantly lower in future Summer Outlook reports. Determining the correct amount will be difficult, however.

The staff believes that the CPUC Resource Adequacy and Planning Reserve Margin proceedings are likely the best forums to obtain the input of all stakeholders and interested parties in order to determine the best assumption or determine a new methodology. Energy Commission staff encourages additional discussion in these proceedings and establishing a stakeholder working group to further study the issue.

There are a number of factors that impact the amount of capacity flowing in either direction on Path 26. Some of these include temperature and load in each region, major generation outages, imports from other balancing authorities, California ISO operating procedures, must-offer waivers, transmission limitations and economics. This working paper will be updated as staff completes additional analysis for these factors.

APPENDIX A

Tables Showing Maximum Temperatures, Maximum Loads and Maximum Hour Ending 1600 Power Flows on Path 26 for Very High Temperature Events 2006 – 2008 All Days

Table A-1 thru **Table A-5** provide relevant data for the 5 "Very High Temperature" events during the summers of 2006 through 2008 and include data for each day of each event as well as days prior to and after the event to capture upward and downward trends. Earlier events were not examined given the lack of hourly Path 26 power flow data for other time periods

"Very High Temperatures" are defined as the PG&E631 maximum daily temperature greater than or equal to 99.0° F. Temperature data was extracted from the Energy Commission's historic temperature database that provides data from 1950 through mid-August 2008. The Energy Commission's database provides temperatures in the "Max631" format which uses regional temperature indices[3] . Raw recordings from various sites which are indexed and then 'tempered' to account for short-term effects of temperatures over a three day period.

Maximum loads and power flows across Path 26 were taken from data supplied by the California ISO to the Energy Commission. HE power flows for each hour of each summer day were examined and it was determined that HE 1600 (4 p.m.) is the usual time of peak demand for the summers of 2006, 2007 and 2008. North to South power flows on Path 26 are indicated by a negative number.

Charts in the analysis above show both "all day" and "Monday-Friday" formats for each event, and the data used was extracted from the following tables.

[3] The regional temperature indices are weighted averages of the observed temperatures at various stations and which are based on air conditioner saturations in these areas. These weights are also used by the California Energy Commission's Demand Analysis Office staff in peak load forecasting and are highly correlated with peak load.

Table A-1: Event 1: June 19 – 28, 2006
All Days

			Max631 (°F)		Max Load (MW)			
DOW #	**DOW**	**Date**	**SCE**	**PG&E**	**SCE**	**PG&E**	**H.E. 16 Flow (MW)**	**Max N-S Flow**
1	Mon	6/19/2006	84.65	87.95	16119.4	14803.8	-3186.6	
2	Tues	6/20/2006	84.86	90.05	16230.2	16197.0	-2846.3	
3	Wed	6/21/2006	85.06	94.65	16195.7	17647.6	-2485.0	
4	Thurs	6/22/2006	84.97	99.34	16832.1	18423.1	-1861.1	
5	Fri	6/23/2006	87.42	**99.55**	17052.4	17801.6	-2480.6	
6	Sat	6/24/2006	90.78	97.38	14894.4	15926.7	-1818.7	
7	Sun	6/25/2006	94.09	96.11	15433.9	16278.6	-2072.9	
1	Mon	6/26/2006	93.75	94.51	17927.5	17929.3	-1279.8	
2	Tues	6/27/2006	93.78	92.30	16438.7	16948.3	-2676.2	
3	Wed	6/28/2006	**96.71**	91.26	19276.2	16269.6	**-3248.4**	
		Max T	**96.71**	**99.55**				**-3248.4**

Source: CA ISO Subpoena data and Energy Commission Staff

All Days: Max631 temperatures were not simultaneous. The maximum HE 1600 North to South flow (3,248.4 MW) on June 28 occurred well after the peak PG&EMax631 period of June 22 and 23. The highest PG&EMax631 temperature occurred on Friday, June 23 when the HE 1600 North to South flow was -2,480.6 MW, well under 3,000 MW.

M-F: Same as "All Days."

Table A-2: Event 2: July 13 – 29, 2006
All Days

			Max631 (°F)		Max Load (MW)			
DOW #	**DOW**	**Date**	**SCE**	**PG&E**	**SCE**	**PG&E**	**H.E. 16 Flow (MW)**	**Max N-S Flow (MW)**
5	Thurs	7/13/2006	96.86	91.25	19738.5	17026.1	-2874.1	
6	Sat	7/15/2006	101.65	94.06	19077.6	15673.4	**-3228.3**	
7	Sun	7/16/2006	97.41	97.49	17607.8	16363.0	-2683.8	
1	Mon	7/17/2006	95.66	101.72	20087.2	18965.1	-1612.9	
2	Tues	7/18/2006	94.28	100.64	20120.7	18805.7	-1511.9	
3	Wed	7/19/2006	92.67	99.19	19965.9	18285.8	-2099.3	
4	Thurs	7/20/2006	92.46	100.10	19902.8	19073.4	-1244.3	
5	Fri	7/21/2006	96.93	101.90	21089.8	19509.7	-2045.8	
6	Sat	7/22/2006	**105.13**	105.59	19726.1	19316.4	-287.9	
7	Sun	7/23/2006	102.65	**107.74**	18401.1	18794.7	630.5	
1	Mon	7/24/2006	102.54	107.10	21113.8	20570.1	-817.4	
2	Tues	7/25/2006	97.20	105.51	21008.2	20557.1	-445.0	
3	Wed	7/26/2006	98.12	101.85	21450.8	19618.0	-1363.8	
4	Thurs	7/27/2006	94.09	96.85	20106.9	18267.9	-1875.2	
5	Fri	7/28/2006	90.99	92.48	19053.3	16669.3	-3026.0	
6	Sat	7/29/2006	86.71	90.08	15304.9	14663.6	-2881.7	
		Max T	**105.13**	**107.74**				**-3228.3**

Source: CA ISO Subpoena data and Energy Commission Staff

All Days: This long-term event (16 days) featured Max631 temperatures that were almost simultaneous over the three hottest days for both regions (Sat. - Mon., July 22 - 24). They also feature a "lagging" of PG&EMax631 temperatures exceeding the 99.0° F threshold. In fact, the non-simultaneous portion shows SCEMax631 temperatures descended while PG&EMax631 temperatures rose. Thus, HE 1600 flows were either very low North to South values or low South to North values on these three days. The maximum North to South HE 1600 flow value occurred on the second day of the event and exceeded 3,000 MW. However, this was when SCEMax631 was above the SCE "very hot" (>= 101.5° F) and PG&EMax631 was well below the "very hot" threshold of >= 99.0° F. The first, third and last two days of the event exhibited North to South HE 1600 flow values approaching 3,000 MW.

M-F: Again, very similar to the "all days" results, but only Monday, June 24, exhibited very hot coincident Max631 temperatures, and the maximum North to South HE 1600 flow value occurred on the last day of the event and four days after the coincident temperature day.

Table A-3: Event 3: July 2 – 9, 2007
All Days

			Max631 (°F)		Max Load (MW)			
DOW #	**DOW**	**Date**	**SCE**	**PG&E**	**SCE**	**PG&E**	**H.E. 16 Flow (MW)**	**Max N-S Flow (MW)**
1	Mon	7/2/2007	94.03	88.25	18667.9	15709.2	-1752.2	
2	Tues	7/3/2007	**94.93**	89.64	18721.3	16432.8	**-2731.5**	
3	Wed	7/4/2007	92.07	95.34	15767.2	16191.1	-672.5	
4	Thurs	7/5/2007	90.49	**99.97**	18349.2	19213.1	362.6	
5	Fri	7/6/2007	90.37	99.28	18457.3	17920.0	-823.3	
6	Sat	7/7/2007	90.41	92.80	15830.8	14182.4	-1869.2	
7	Sun	7/8/2007	86.75	92.54	14234.9	14304.5	-1192.4	
1	Mon	7/9/2007	84.56	91.48	16284.2	16070.6	-1536.3	
		Max T	**94.93**	**99.97**				**-2731.5**

Source: CA ISO Subpoena data and Energy Commission Staff

All Days: This event features a situation where north state temperatures became very hot even though south state temperatures never reached the 101.5° F threshold. This is an event that argues against south state temperatures always driving north state temperatures. SCE temperatures were never very high during this event. Indeed, SCEMax631 temperatures never approached the 101.5° F threshold any closer than 94.9° F, a 6.6° F difference. Maximum PG&E temperatures spiked over 10° F from Tuesday, July 3 to Thursday, remained above the 99.0° F threshold on Friday, then dropped about 6.5° F on Saturday.

The maximum North to South HE 1600 flow rate of 2,731.5 MW occurred two days prior to the first day of the very high PG&EMax631 temperature on Thursday, July 4. The HE 1600 flow on July 4 was in the South to North direction at a time when the SCEMax631 temperature was almost 12° F below the 101.5° F SCE threshold.

M-F: The only difference from the "all days" data is not capturing Saturday's rapid drop in temperature in the north state of almost 7° F.

Table A-4: Event 4: June 16 – 24, 2008
All Days

			Max631 (°F)		Max Load (MW)			
DOW #	**DOW**	**Date**	**SCE**	**PG&E**	**SCE**	**PG&E**	**H.E. 16 Flow (MW)**	**Max N-S Flow**
1	Mon	6/16/2008	89.97	86.46	18688	15807	-3002.7	
2	Tues	6/17/2008	92.03	89.64	19788	16791	**-3164.7**	
3	Wed	6/18/2008	95.32	92.29	20758	17549	-1936.8	
4	Thurs	6/19/2008	96.77	95.62	21669	18885	-1656.6	
5	Fri	6/20/2008	100.84	100.17	22365	20426	-1157.7	
6	Sat	6/21/2008	**103.43**	**102.13**	21266	18588	-1582.7	
7	Sun	6/22/2008	100.44	94.79	20633	15916	-2676.9	
1	Mon	6/23/2008	94.63	87.20	20305	15777	-2953.3	
2	Tues	6/24/2008	88.53	86.57	18302	16172	-1713.1	
		Max T	**103.43**	**102.13**				**-3164.7**

Source: CA ISO Subpoena data and Energy Commission Staff

All Days: The SCE and PG&E Max631 temperatures were simultaneously very high on the sixth day of the event, Saturday, June 21, but by the following day the PG&EMax631 temperature had dropped about 7.5° F, well below the 99.0 °F threshold. The highest HE 1600 flow occurred on Tuesday, June 17 (3,164.7 MW). After the simultaneous hot days, the HE 1600 flows approached 3,000 MW, but, as stated above, the PG&EMax631 temperature had dropped about 7.5° F, well below the 99.0° F threshold. .

M-F: Without the weekend days, this would not be considered as an event, and ignoring the weekends misses the simultaneous highs on Saturday, June 21 and the rapid decrease of the following day.

Table A-5: Event 5: July 5 - 13, 2008
All Days

			Max631 (°F)		Max Load (MW)			
DOW #	**DOW**	**Date**	**SCE**	**PG&E**	**SCE**	**PG&E**	**H.E. 16 Flow (MW)**	**Max N-S Flow**
6	Sat	7/5/2008	**92.40**	87.05	17683	15317	**-2451.1**	
7	Sun	7/6/2008	89.10	90.33	17066	16885	-1368.1	
1	Mon	7/7/2008	89.84	96.60	19895	20625	420.3	
2	Tues	7/8/2008	89.41	102.36	19763	21835	1175.3	
3	Wed	7/9/2008	86.94	**103.21**	18889	21636	794.5	
4	Thurs	7/10/2008	85.47	101.34	19392	20869	710.4	
5	Fri	7/11/2008	84.41	95.34	17672	17729	-1242.0	
6	Sat	7/12/2008	87.24	90.77	17283	15887	-1567.6	
7	Sun	7/13/2008	88.75	90.05	17354	16457	-1256.3	
		Max T	**92.40**	**103.21**				**-2451.1**

Source: CA ISO Subpoena data and Energy Commission Staff

All Days: The Max631 temperatures were never simultaneous between SCE and PG&E during this event. This is another instance when north state high temperatures are not driven by high south state temperatures.

Although the PG&EMax631 temperature increased rapidly over three days from 87.05° F on Saturday, July 5 to over 101° F on Tuesday through Thursday, SCE's temperatures never exceeded 90° F. The maximum HE 1600 North to South power flow, 2,451.1 MW, occurred well before the very hot days for the north, and when PG&EMax631 temperatures were very hot, the flows were South to North. This is expected because SCEMax631 temperatures were so low.

M-F: This time period is same as the "all days" data.